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ABSTRACT

This study investigated the following questions: (1) Are newborn individual differences relevant for infant developmental outcomes?; (2) Can any continuity be found between neonatal and infant behavioral characteristics?; (3) Are maternal behavioral styles influenced by the newborn's individual characteristics?; and (4) Do initial maternal interactional styles explain the variations of early infant developmental outcome? The subjects of the study were 24 preterm infants. Data were collected in three waves. The mother-infant dyads were observed in free interaction as soon as the babies could be handled in room air. The Brazelton Neonatal Behavioral Assessment Scale (BNBAS) was administered at 50- to 52-day post-conceptional ages. At 6 to 8 months corrected ages the infants were assessed using the Bayley Scales of Infant Development (BSID). According to the results, perinatal state had limited effects on neonatal behavior. None of the variables from earlier measurement points predicted the developmental level at 6 to 8 months. However, the significant correlations found between BNBAS scores and the BSID behavior ratings suggested that the BNBAS was able to tap individual characteristics of neonatal behavioral organization which had long-term implications. Measures of term-time maternal behavior did not contribute to the prediction. (Contains 33 references.) (Author/EV)

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CONTINUITY AND DISCONTINUITY IN PRETERM INFANTS' EARLY DEVELOPMENT

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The developmental implications of premature birth are rather complex and far from being fully revealed. The information available about the relatively low-risk preterm children is particularly sketchy, as most of the research has focused on populations of high-risk preterms in which the role of prematurity is confounded with the effects of various perinatal complications (Vohr & Garcia-Coll, 1988). There is an enormous inter-individual variety of neonatal behavioural and autonomic organisation even in the healthy preterm infants. Evidently it is determined by the degree of maturation (Ferrari et al, 1986; Holmes et al, 1982); nevertheless gestational age does not explain all of the variation. Preterm babies are exposed to the extrauterine environment untimely. The stimulation which is inadequate for their immature organisms may easily overload the nervous system, and interfere with the normal maturational processes (Als, Lester, Tronick, & Brazelton, 1982; van Beek & Geerdink, 1989).

The longitudinal significance of newborn individual differences constitutes a further research question, with special implications in infants born at medical risk. The predictive power of perinatal risk or optimality scales has proved short lived. A number of authors, however, have reported remarkable links between neonatal behavioural and autonomic organisation and later infant outcome. In many of these studies neonatal measures were derived from the Brazelton Neonatal Behavioral Assessment Scale (Covington, Cronenwett, & Loveland-Cherry, 1991; Green, Bax, & Tsitsikas, 1989; Jakobvitz & Sroufe, 1987; Kato, 1991; Lester, 1984; Moss, Colombo, Mitchell, & Horowitz, 1988; Nugent, 1991; Tirosh, Abadi, Hare, Berger, & Cohen, 1992). The literature also reflects an increasing recognition of caregiver-infant interactions as further potential contributors to the outcome (Bakeman & Brown, 1980; Beckwith & Cohen, 1987; Bornstein & Tamis-LeMonda, 1989; Smith, Landry, Swank, Baldwin, Denson, & Wildin, 1996; Spiker, Ferguson, & Brooks-Gunn, 1993; Tamis-LeMonda, Bornstein, Baumwell, & Damast, 1996; Wijnroks, 1998).

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Our ongoing follow-up study of preterm infants was designed in order to provide some evidence relevant to the above issues. In this article results of the analysis of data from the first data collection points are presented, organised around four research questions: 1) Do newborn individual differences (perinatal status and neonatal behavioural variations) bear any relation to infant developmental outcome? 2) Can any continuity be found between neonatal and infant behavioural characteristics? 3) Are maternal behavioural styles influenced by the baby's individual characteristics (gender, perinatal status, or behaviour) already in the initial interactions? 4) Can the initial maternal interactional styles explain the variations of early infant developmental outcome?

METHOD

Subjects

Twenty-four preterm infants and their mothers participate in the study. The infants were born between 29 - 33 weeks of gestation (mean GA 30.7 weeks, *SD* 1.4), with birthweights of 1100 - 1980 grams (mean BW 1479.2 grams, *SD* 235.1). They had no congenital abnormalities or obvious sensory deficits, and their perinatal course was free of severe complications. Their risk scores on the Obstetric and Postnatal Complication Scales (Littmann & Parmelee, 1978) ranged between 8-17 (mean 11.8, *SD* 2.7), and they were regarded by the neonatologists as low- to moderate risk babies.

The gestational age range was chosen with certain considerations in mind. After 28 weeks of gestation, with good perinatal care and if the organism is otherwise healthy, the degree of maturation enables the central nervous system to adapt the vital autonomic processes to the extrauterine conditions without life-threatening difficulties. On the other hand, it is an extremely important period in the development of alertness and state regulation, and in this respect these preterms are expected to be still markedly different from the full-term neonates (St-Anne Dargassies, 1974).

The male / female ratio in the sample is 58 / 42 %. None of the perinatal variables was related to gender.

Design and Instruments

Mothers who had given birth prematurely to babies meeting the criteria of sample selection described in the Method section were contacted in the hospital and invited to participate in the study. The first wave of data collection took place as soon as the infants could be handled in room air, still in the hospital nursery, at gestational ages of 36-39 weeks. Mothers were observed while they were together with their babies in a free situation, without any caregiving tasks. In the 2nd or 3rd post-term week (depending on the infant's condition) the Brazelton Neonatal Behavioral Assessment Scale *(BNBAS* 3rd Edition, Brazelton & Nugent, 1995) was administered. At the next follow-up, at 6-8 months corrected age, the infant outcome was assessed by the Bayley Scales of Infant Development *(BSID-II*, Bayley, 1993).

All of the observational and testing sessions were videotaped. In compiling maternal interactive behaviour rating scales a number of sources had been drawn upon (Beckwith & Cohen, 1987; Bigsby, Coster, Lester, & Peucker, 1996; Brown, Bakeman, Snyder, Fredrickson, Morgan, & Helper, 1975; Crnic, Ragozin, Greenberg, Robinson, & Basham, 1983; Leyendecker, Lamb, Schölmerick, & Fricke, 1997). The selected items were arranged in five-point rating scales which were refined following a pilot coding. In order to check the reliability of rating one-third of the records were scored by two observers. Interrater agreement was 97% if a difference of one scale point is accepted; perfect match was achieved in 77 % (for more details on the scales see Medgyesi, Tóth, & Kalmár, 1998). The *BNBAS* and the *BSID* recordings were scored by trained examiners.

Measures

Gestational Age, *Birth Weight*, and the *Risk Index* served as indicators of the infant's perinatal state.

Three factors were derived from the Neonatal Maternal Behaviour Rating Scales (Principal Component Extraction, Varimax Rotation with Kaiser Normalisation) which were labelled as follows: 1) Delight in Infant / Affectionate Sensitivity; 2) Activity / Verbal Stimulation; 3) Assured Interest / "Manipulating" (frequent touching and grasping the baby). The factor scores were used as variables.

Aggregated scores of *BNBAS* items for *Habituation, Orientation, Motor Quality, Range of States, Regulation of State, and Autonomic Stability* (Brazelton & Nugent, 1995) as well as the supplementary items (originating from the "Kansas Supplement", Horowitz, Sullivan, & Linn, 1978, and the "Assessment of Preterm Infants' Behavior", Als, Lester, Tronick, & Brazelton, 1982) were included in the analysis.

As measures of infant outcome the *BSID-II. MDI, PDI,* and the *Behavior Rating Scale Factors (Orientation / Engagement, Emotional Regulation, and Motor Quality)* were used.

At the present stage of data processing Pearson product-moment correlations and Student's *t*-tests were performed.

RESULTS

Neonatal behavioural performance in preterm infants and perinatal status:

Birth Weight was significantly related to two *BNBAS* supplementary items. The VLBW (< 1500 g) babies had less effective *state regulation* and were less *robust* (t = 2.27 and 2.24, respectively, $p<.05$ for both). Higher *risk* marginally correlated with poorer *autonomic stability* and *orientation* (r = -.35 and -.39, $p<.10$). *Gestational Age* was negatively correlated with the *quality of alertness* and *habituation* (r = -.42, $p<.05$, and -.56, $p<.01$).

Gender effects:

The baby's gender was related to three *BNBAS* measures. Female babies scored higher in *autonomic stability* and *orientation* (t = 2.28 and 2.12, $p<.05$ for both), and were marginally less *irritable* (t = 1.79, $p<.01$). Girls also displayed more optimal *Emotional Regulation* as measured by the *BSID* Behavioral Rating Scale (t = 2.46, $p<.05$).

Maternal interactional style and neonatal behaviour:

Maternal Activity / Verbal Stimulation significantly correlated with the *BNBAS Orientation - Alertness* Cluster (r =.56, $p<.01$). There was a marginally significant negative correlation between *Assured Interest / "Manipulation"* and the *BNBAS Habituation* Cluster (r = -.48, $p<.10$).

Neonatal prediction of infant outcome

None of the variables from the neonatal measurements predicted the *MDI* or the *PDI* at 6 - 8 months. The *BSID Emotional Regulation* factor was significantly predicted by the *BNBAS Orientation - Alertness* Cluster ($r = .54$, $p < .01$), and two supplementary items (*Quality of Responsiveness* and *State Regulation*, $r = .40$ and .41, $p < .05$). The *Orientation / Engagement* factor was marginally correlated with the *BNBAS Motor* Cluster ($r = .37$, $p < .10$), and the State Range Cluster ($r = -.38$, $p < .10$).

The significant correlations and *t*-test results are summarised in Figure 1.

- Insert Figure 1 about here -

DISCUSSION

The measured variables of perinatal state had limited effects on the neonatal behavioural organisation. The very-low birthweight babies were disadvantaged in some respect, and the accumulation of risk factors seemed to have adverse effects even in a sample of preterm infants in which the range of risk was restricted by the selection criteria. The negative correlations of *Gestational Age* with two *BNBAS* variables were unexpected. Underlying these intrauterine growth retardation might be suspected. The latter factor was included in the perinatal risk scale, but at that stage of data analysis its contribution was not tested separately.

None of the variables from earlier measurement points predicted the *MDI* or the *PDI* at 6 - 8 months. The lack of perinatal status effects is likely to be due to the purposefully limited heterogeneity of the sample. Our data did not corroborate the few findings available in the literature (Kato, 1991; Nugent, 1991; Vaughn, Taraldson, Crichton, & Egelund, 1980) on the relationship between *BNBAS* measures and infant mental development. However, the subjects of the above studies were not preterm babies, and the perinatal risk factors associated with premature birth can be expected to confound the normal neonatal antecedents of later developmental performance. On the other hand, in our low-to-moderate risk preterm sample poorer neonatal scores were not indicators of irreversible CNS compromises. In Lester's (1984) study recovery curve parameters from repeated *BNBAS* examinations, rather than absolute scores predicted 18-month mental status in both term and preterm infants.

Consistently with earlier reports on the relationship between *BNBAS* measures and infant behavioural organisation (Covington et al., 1991; Green et al., 1989; Jakobvitz & Sroufe, 1987; Tirosh et al., 1992), we found remarkable correlations between *BNBAS* scores at 2-3 weeks post-term and *BSID behaviour ratings* at 6-8 months. Newborn *Orientation* and *Quality of Alertness* predicted *Emotional Regulation* scored on the *BSID Behavior Rating Scale* several months later. The marginally significant correlations of the *BSID Orientation / Engagement* factor with two *BNBAS* Clusters *(Motor* - positive, *State Range* - negative) are hard to interpret. Altogether these results suggests that the *BNBAS* is able to tap individual characteristics of neonatal behavioural organisation which have long-term implications. In our study of a low-to-moderate risk preterm sample some of the supplementary items proved to be particularly meaningful.

Horowitz & Linn (1984) emphasized the need of combining *BNBAS* scores with measures of the infant's environment in order to enhance the power of prediction. Our measures of term-time maternal behaviour failed to serve this purpose as they did not contribute to the prediction of *MDI* and *PDI*, nor the *BSID behavioral factors*. The underlying reason may be that the observations took place at a very early stage of mother-infant interactions when mothers had too little previous experience with their babies, therefore many incidental factors may have influenced their behaviours. The only significant correlation with a maternal variable - the one between *Maternal Activity / Verbal Stimulation* and the *BNBAS Orientation / Alertness* Cluster -, however, is notable, as it suggests that potential transactional effects should be taken into consideration already at this early phase of development.

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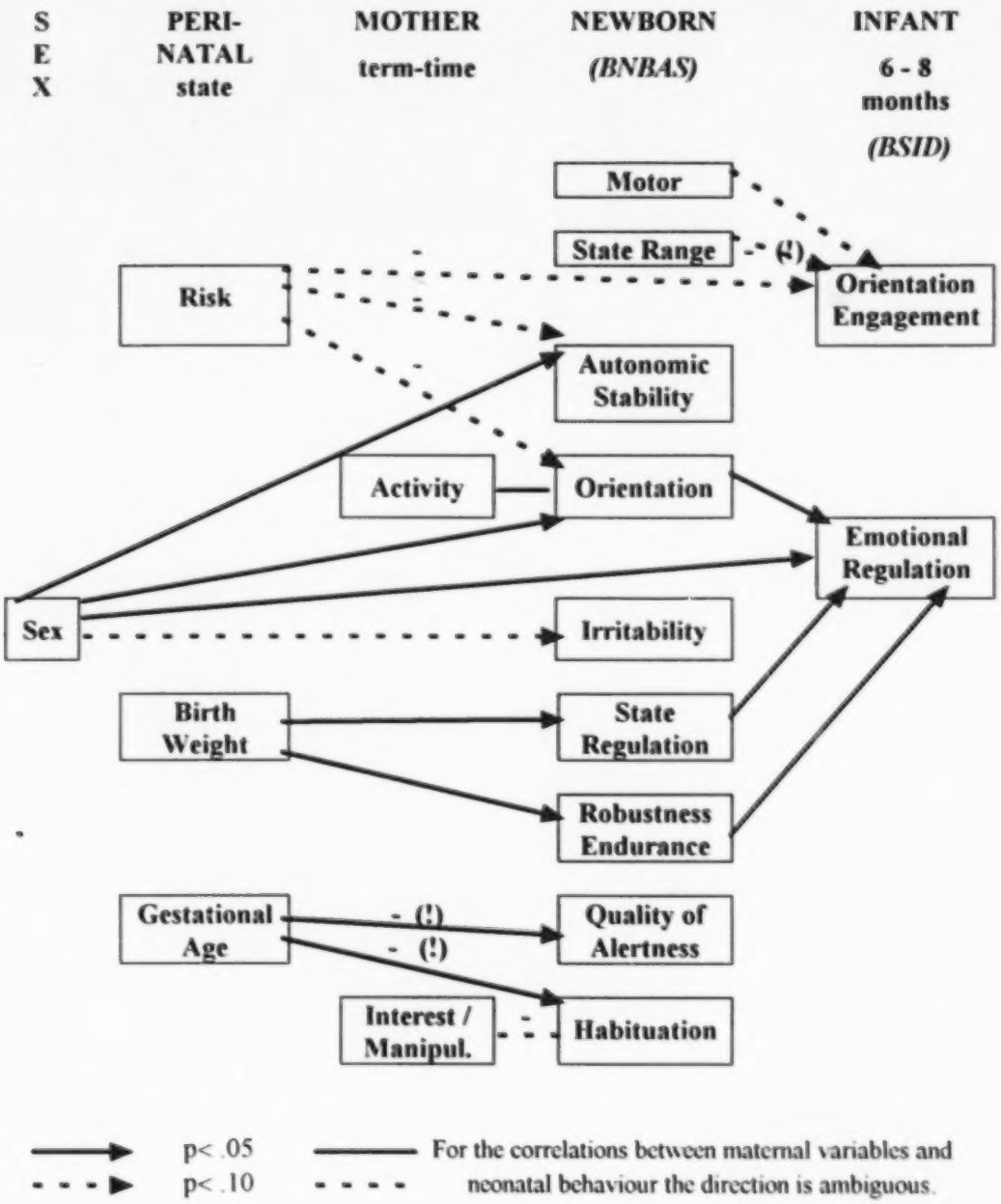

Antecedent Correlates of Neonatal and Infant Behaviour

Figure 1

CONTINUITY AND DISCONTINUITY IN PRETERM INFANTS' EARLY DEVELOPMENT

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Abstract

The study reported in the article aimed to contribute data towards answering the following research questions: 1) Are newborn individual differences relevant for infant developmental outcome? 2) Can any continuity be found between neonatal and infant behavioural characteristics? 3) Are maternal behavioural styles influenced by the newborn individual characteristics? 4) Do initial maternal interactional styles explain the variations of early infant developmental outcome? The subjects of the study were twenty-four preterm infants. Data were collected in three waves. The mother-infant dyads were observed in free interaction as soon as the babies could be handled in room air. The Brazelton Neonatal Behavioral Assessment Scale was administered at 50-52-day post-conceptional ages. At 6-8 months corrected ages the infants were assessed using the Bayley Scales of Infant Development. According to the results perinatal state had limited effects on neonatal behaviour. None of the variables from earlier measurement points predicted the developmental level at 6-8 months. However, the significant correlations found between BNBAS scores and the BSID behaviour ratings suggest that the BNBAS was able to tap individual characteristics of neonatal behavioural organisation which had long-term implications. Measures of term-time maternal behaviour did not contribute to the prediction.